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THE ADVANCEMENT OF SCIENCE[1]

By Dr. E. P. PHILLIPS

CHAIRMAN OF THE COUNCIL, PRETORIA TECHNICAL COLLEGE

IN the evolution of science there have been changing environments which have profoundly influenced the progress of science. The general cultural background of a period, the printing press, the founding of the famous scientific academies in the latter part of the seventeenth century and early in the eighteenth century, politics, philosophical doctrines, geographical exploration, religion, superstition, etc., which, throughout the period of which we have any knowledge, have hastened or hindered the advancement of science. The church has played its part in creating an environment in which science struggled for freedom, though it was not antagonistic to science which conformed to its teachings. The Mosaic account of Creation and of the Flood, the belief in a geocentric universe with a heaven and a hell close at hand, for example, delayed the progress of geology and astronomy. Science has gradually but relentlessly broken down some of these barriers. Copernicus exploded the belief in a geocentric universe; geologists brought evidence to bear on the age of the earth; Darwin taught us to think in terms of evolution; Pasteur dispelled the darkness and ignorance concerning disease, and Fraser suggested we should reconsider our ideas about many of our beliefs and to look for their origin in the beliefs held by primitive peoples.

Not only have philosophic and scientific thought at various times created an environment which influenced the advancement of science, but mechanical aids to sci-

[1] Concluding part of address of the president of the South African Association for the Advancement of Science, June 29, 1942.

ence have also profoundly influenced the environment in which scientific advance became possible. The microscope, from the simple beginnings of Robert Hooke and van Leeuwenhoek in the seventeenth century, has played an important role, not only in biology, but also in geology and in metallurgical research. Astronomy could not have advanced without the aid of the telescope, the spectroscope and the pendulum clock. The photographic plate has been an invaluable aid to science, especially to astronomy, and recently the film has come to the aid of science in the study of the structure and behavior of micro-organisms. It should not be forgotten that underlying all the numerous mechanical aids to science, are scientific principles discovered by men of science and which have been applied and developed over a long period.

When we regard science as an indivisible whole and trace its development, we become more impressed than ever with the influence of changing environments at different periods on the advancement of science. When we look back on the gradual advancement of science from its early beginnings to our times, we must admit that a spirit has been created that should act as a beacon to a better world if men would be guided by the teachings of science. As in organic evolution, mutations may suddenly arise in science and may persist or die in a longer or shorter period depending on a favorable or unfavorable environment resulting from fresh knowledge. When Newton and Leibnitz about the same time, and probably independently, discovered the fundamental principles of the calculus it can be regarded as a mutation—something that suddenly appeared and incidentally persisted as one of the most powerful tools ever given to mathematicians. A complete break between organic and inorganic chemistry—another example of mutation—happened in the year 1828 when Wöhler prepared urea from ammonium cyanate. Avogadro's hypothesis that equal volumes of gases at the same temperature and pressure contain the same number of molecules is another example of a mutation that was able to persist in the environment of the Laws of Constant Proportions, Multiple Proportions and Reciprocal Proportions. The demonstration by Galileo that the acceleration of falling bodies is the same, irrespective of their mass, was a new mutation that appeared in the evolution of science and which has persisted. Ptolemy's views about a fixed earth round which the sun and stars revolved could perhaps be cited as a mutation that persisted until it died in the new knowledge acquired in the sixteenth century. Another example might be Stahl's phlogiston theory of combustion, which could not survive in the environment created by Priestley and Lavoisier. But science does not generally evolve in this manner, but from small continuous variations that may or may not persist. A study of the development of ideas concerning the cell and organic evolution and the conception of the atom, for example, will provide numerous illustrations of small or larger variations that have persisted or died in the environment in which they appeared. The evolution of science also provides many examples of a struggle for existence in adverse environments. The veneration of the views and opinions of the Greeks, *e.g.*, Aristotle and Galen; the spirit of superstition that existed for centuries; the attitude of the church; all provided an unfavorable environment in which science struggled for existence. The fundamental truths of science, while their rapid development was retarded, persisted even under such adverse conditions and flourished and spread.

If you accept my thesis that the origin of science lies in the pre-history period of man and that its advancement is a product of the human intellect, you must also concede that the stage modern science has reached is the greatest triumph of the human mind. I have often asked myself the question whether the development of science has anything to teach us. I personally think it has. I can never believe that man, notwithstanding the terrible mess he has made of his social and economic problems, has not the brain capacity eventually to solve them. Science has taught us that, when dealing with scientific problems, the subject must be approached with an unbiased mind willing to be led wherever truth leads and not to be influenced by preconceived ideas or prejudices. The history of science provides us with many examples of theories and beliefs being discarded when fresh facts were brought to light. The world of science is quite unperturbed at such occurrences and accepts them as the price to be paid for a more complete understanding of nature, rejoicing that a step nearer the truth has been attained. Science as such will not solve all our present-day social and economic problems, but I am certain that they can be solved if minds trained in scientific methods are brought to bear upon them. When men are prepared to expend the same energy in applying scientific knowledge to large human problems, as they expend on physical inventions, on industry and on commerce, many such problems will be within sight of solution. The intellectual world must have been shocked when Copernicus, on observed facts, stated that the earth moves round the sun and not the sun round the earth; the world was shocked when Darwin stated that the facts of nature did not support the belief in a special creation. Is there any reason why the world of vested interests, the world of greed, the world of selfishness, should not be shocked out of their complacency by the searchlight of scientific methods of inquiry? We *know* that the

social and economic conditions under which the majority of men live could materially be improved—no proof is needed—they are plain for every thinking man to observe; yet a state of affairs is allowed to continue in our social and economic systems that would not be tolerated for a moment, had they been problems in a matter of pure science. Science can assist to alleviate, and science has assisted in alleviating, the conditions under which human beings live. It remains for the statesman, the administrator, the politician to bring to bear the scientific outlook on the problems we are still faced with. We see in the history of science how opposition to new thought has again and again been overcome. History also provides us with examples such as the opposition to general education, the opposition of vested interests to the abolition of slavery, but both were eventually broken.

The whole organic world, the universe, our thought, beliefs, customs, etc., have all undergone a process of slow evolution. In many ways man has consciously assisted evolution in desirable directions in the social and economic spheres. The process has been slow, but with the will and the right spirit it can be still further speeded up. There are dangers to be faced, as for example a government forcing a system on the people that may destroy some of their inherent rights as individuals. The average man has not lost imagination nor is he usually a person without a sense of good-will towards his fellows; by mutual trust and cooperation many reforms could spring from below upwards and not be forced from above on the people.

An American sociologist wrote that one of the most terrible examples of unscientific mindedness is an eminent physical or biological scientist speaking on social matters. As I only lay claim to having some little knowledge of biology, I shall *not* fall into the error of making dogmatic statements, though I consider the awakening interest of scientific workers in social problems which science has created, is a healthy sign of our age. I do, however, make a plea that some of our urgent social problems such as adequate food and housing, the opportunities for the enjoyment of physical fitness and health, be investigated by minds trained in the methods of scientific approach—a method that has solved many problems in the sphere of natural phenomena. One of the methods by which this may be attained is by some modification to our educational system, whereby young people may be trained, as part of their general education, in the appreciation of science and the scientific method by teachers fully competent to undertake such training. Unfortunately science is not always presented as something living but, as a well-known novelist put it, is presented "as a corpse which bit by bit we painfully dissect." Intellectual docility is often evidenced in our educational system. More importance is attached to the acquisition of correct beliefs than to the methods by which such beliefs are formed—authority instead of doubt is stressed. A knowledge of the history of science and of thought generally would stress that the doubting spirit of man has been the chief spur to the advancement of science and to human progress.

In another organization with which I have had the honor of being associated for many years, I have consistently advocated the policy of attracting young men of ability to its councils. The young man with intelligence approaches many problems unhindered by tradition or conservatism, while the older men of experience, if their minds have not atrophied so that they are unreceptive to new ideas, may act as a steadying influence. I consider that in all spheres of consultation on scientific matters the younger men of promise should be represented on the consultative bodies and their opinions given careful consideration.

It may savor of over-optimism for a generation that has lived through two terrible wars still to believe that the world can be spared such tragedies and that human beings may live full and useful lives untroubled by the specter of want in a world of plenty. But I am an optimist. I can not regard the triumphs of the human mind, as evidenced in one sphere, *viz.*, the advancement of science, as being without some significance and hope. This more especially when we know that civilization has existed for only an infinitesimal fraction of the period since man first appeared upon the earth. Some twentieth century philosophers, as illustrated by Bertrand Russell, are not so optimistic. He writes "the whole temple of man's achievements must inevitably be buried beneath the debris of a universe in ruins—all those things, if not quite beyond dispute, are yet so nearly certain that no philosophy which rejects them can hope to stand."

Even if we accept this doctrine, I think there is still ample time for man to readjust his affairs, so that like the repentant sinner he may meet his ultimate fate without fear.

In conclusion, I end up on a note typifying the outlook and spirit of science—a verse dedicated to Leonhard Stejneger, the American biologist, on the occasion of his ninetieth birthday:

The sons of science walk in endless line bearing the torch;
a few falter and drop,
But the rest close in: they who have a sign
Far on ahead that reads "You must not stop!"
Their quests are strange and wonderful—to bring
The stars to earth, to take the earth to sky;
To know the *what* of every living thing of all times past,
and then the *how* and *why*.

ATMOSPHERIC ELECTRICITY AND ALLIED PHENOMENA[1]

By Dr. W. F. G. SWANN

DIRECTOR, BARTOL RESEARCH FOUNDATION OF THE FRANKLIN INSTITUTE, SWARTHMORE, PENNSYLVANIA

ONE of the greatest mysteries of the universe is the tremendous richness of it all and yet the strange concealment of that richness. The sun shines to-day as it probably shone a thousand million years ago in an age when there was no earth, no life and no conditions to support life. Yet in that formless age there existed in the properties of the materials of the sun the wherewithal to fashion in future times a dynamo, an automobile and the countless adjuncts of our civilization of to-day, things which would have had no meaning or place in the fires of the great orb itself.

If the period from the dawn of history be shrunk into a day, we shall find that the first twenty-three hours of that day are barren as far as natural philosophy is concerned; for it is only in the last hour that science was born; and even as the human child develops in its struggle towards manhood, so this child of nature, born to a civilization six thousand years old, has grown, and with such ever-increasing strength that, in the last fifteen minutes of its existence, in the last fifty years of actual time, it has outshone all the achievements of its youth and adolescence and has torn from nature more of her secrets than she had vouchsafed to man in the whole previous history of his existence.

My task this afternoon is to open up for you a small chest in the vaults which store the jewels of the universe and show you a few of those treasures which constitute the science of atmospheric electricity.

From time immemorial, the thunderstorm has symbolized in the mind of primitive man the wrath of the Almighty, and the lightning flashes the decimating bolts of Jove. It was Benjamin Franklin, the founder of the society from whose halls I am now speaking, who, nearly two hundred years ago, in his famous kite experiments performed not far from the spot on which I now stand, showed that the lightning flash is simply the big brother of the ordinary electric spark.

I need hardly remind you that science has come to know two kinds of electricity, called positive and negative electricity because the two kinds possess the power to neutralize each other's effects when they are mixed. When separated, they tend to rush together under their mutual attraction, and may raise to incandescence anything, such as the atmosphere, which impedes them in their paths. It may be of interest to remark that while a piece of iron, for example, is electrically neutral under ordinary conditions, a cubic inch of it contains so much positive and negative electricity that if we could separate these charges and concentrate them at two points an inch apart, they would attract each other with a force of more than a hundred million million million tons.

It is now a universally accepted belief that thunderstorms and lightning are secondary phenomena brought about by the abnormal meteorological conditions which we always find associated with them, and nearly all theories of thunderstorms invoke some mechanism by which falling raindrops, snow or hail become charged with one kind of electricity, while the air and smaller drops capable of being carried up by the rising column of air associated with the storm are charged in the opposite sense. The separation of electricity proceeds until electrical tensions are set up sufficient to result in a lightning flash, sometimes between one mass of air and another, sometimes between a mass of air and the ground. However, while the thunderstorm is the most spectacular manifestation of electrical activity in the atmosphere, that atmosphere is at all times the seat of more modest electrical phenomena of profound interest to the student of science.

Our earth is not an electrically neutral body. Its surface is coated with a layer of negative electricity. The amount of this electric charge is such that there is about one and a half times as much difference of electrical pressure or, to use the technical expression, electrical potential, between the surface and a point one yard above it as there is between the terminals of our lighting circuits. The electrical pressure or potential continues to rise as we mount into the atmosphere but at a decreasing rate, until at an altitude of ten miles or so there is very little further change. However, the net result is that between a point ten miles high and the surface of the earth there is an electrical pressure difference of about a hundred and fifty thousand volts.

Now the atmosphere is a conductor of electricity. As compared with a substance like copper, for example, its conductivity is almost inconceivably small. A column of air one inch long offers as much resistance to the flow of the electric current as would a copper cable of the same cross-section extending from here to the star Arcturus and back several times. In spite of the smallness of this power of the atmosphere

[1] World-wide broadcast of the American Philosophical Society and WRUL, Philadelphia, May 22, 1942.

to conduct electricity, it is sufficient to insure that 90 per cent. of the earth's electric charge would disappear in ten minutes if there were no means of replenishing the loss. The total current flowing from the earth amounts to about 1,000 amperes, that is, enough current to light about 3,000 ordinary incandescent lamps. The total power dissipated in this current is about 150,000 kilowatts. That would be quite a lot to pay for, but it is not very much on the scale of operations of cosmical phenomena, for the sun's radiation delivers to the earth about a thousand million times as much power as this.

The process by which the earth's charge is continually replenished has been for many years a puzzle to the student of atmospheric electricity. From time to time some new fact of physics has seemed the thing necessary to provide a solution of the problem, and then, as we learned more, the explanation appeared inadequate. Frequently we became conscious of the philosophy of the old darky, who remarked: "It ain't what you don't know that gets you into trouble, but what you do know and ain't so."

One of the oldest theories of the replenishment of the charge is a theory proposed by the English physicist, C. T. R. Wilson, who claimed that rain is, on the whole, charged with electricity of the kind to be found on the earth's surface, and that this rain, in descending to the earth, brings its charge with it, leaving the opposite kind in the atmosphere. This theory has had to fight many objections, but it is possible that in the long run it may contain the essentials of the facts.

To return to the electrical conductivity of the atmosphere, we all know that the atmosphere is composed of a large number of molecules of gas. Each of these is in part built up out of particles of electricity of both kinds, so that the molecule is neutral as a whole. By certain agencies it is possible to detach a particle of negative electricity—an electron, we call it—from a molecule, leaving the remainder positively charged. The electron wanders about and soon attaches itself to a neutral molecule so that as a result we have negatively and positively charged molecules. These charged molecules move under the influence of electrical forces, their motion constitutes a current of electricity, and their presence is responsible for the power of the air to conduct electricity. In every cubic inch of the air we breathe there are about 10,000 molecules which have lost or gained an electron. Although this seems a lot, it is very small compared with the five hundred million million million molecules which that cubic inch contains. In fact, if a molecule were to go about saying that it had once seen one of its brothers who had lost an electron, the story would be less likely to be believed by the other molecules than would the assertion by some person that he had seen a man with two heads if he were the only person who had seen such a monstrosity during the whole history of the human race.

Now what agencies are responsible for detaching electrons from molecules? One agency is the radioactive material in the air and in the soil. A substance like radium is continually in a state of disintegration. Any given amount of radium disappears to the extent of 50 per cent. of its original amount in 1,600 years, so that if you have a tenth of an ounce of radium, you are at present losing capital to the extent of about $25 a year. As the radium dies it shoots out atomic particles with tremendous speed. One type of particle, the alpha particle, is a positively charged atom of helium traveling with a velocity of 12,000 miles a second. Then there are electrons traveling with speeds comparable with that of light, 186,000 miles a second, and there are gamma rays which are like very penetrating x-rays. All these particles are responsible for breaking up the molecules of air through which they pass. There is only about ten ounces of radioactive material in the whole of the earth's atmosphere, but this amount is sufficient to play a very important role in determining the power of the atmosphere to conduct electricity. Another agency, and practically the only agency over the great oceans where there is no radioactive material, is the cosmic radiation. Professor Millikan will deal with the nature of this radiation in another of these broadcasts, and it will suffice here to say that it or its progeny gives rise to rapidly moving charged particles in our atmosphere, which particles are responsible to a considerable extent for the origin of atmospheric conductivity. Again we are confronted with a phenomenon which, while readily apparent to our large-scale observations, is a very rare phenomenon from the point of view of the individual molecules. If we should liken the detachment of an electron from an atom by a cosmic ray to a murder in the field of human affairs, then we may say that the chance of a molecule in the atmosphere being murdered is about the same as the chance that one of us would be murdered if, with the earth at its present population, only one murder were committed in 300 years. You see that things are relatively peaceful in the world of molecules.

The power of the atmosphere to conduct electricity increases with altitude many times up to altitudes which have been attained, and we have indirect evidence to support the view that at altitudes comparable with 150 or 200 kilometers the conducting power is enormous compared with what it is at the earth's surface. When radio waves pass out from the broadcasting antenna and encounter these highly conducting

regions, they set up electrical currents therein, and these currents emit other radio waves of the same kind as the original ones, but so ordered in their relationship to these original waves that they cancel them as regards their progression towards outer space and reinforce them in regions below. The net result is that we obtain what we call reflection of the waves from these conducting layers. The United States Bureau of Standards keeps continual track of changes in these layers, since their power to reflect radio waves back to the earth is responsible for the whole success of radio broadcasting and particularly for short-wave broadcasting through which you hear my voice at this moment.

Through the efforts of the Carnegie Institution of Washington, atmospheric electric observations have been extended all over the earth, including the great oceans, and several permanent observatories have been set up by the Institution, by the U. S. Coast and Geodetic Survey, and by other organizations, not only in the United States of America, but in Australia, and several other parts of the world. Not only in peace but also in periods of war some collaboration has been maintained even among the warring nations, particularly by the astronomers whose minds, so well attuned to see richness everywhere, find everywhere some good in the world. If only political collaboration among nations were as harmonious as scientific collaboration, how greatly would the brotherhood of man benefit, and how much nearer should we be to that millennium which, through the ages, has been the goal of all mankind.

OBITUARY

VERNON ORLANDO BAILEY
1864–1942

THE achievement in personality that characterized Vernon Bailey, who died at his Washington, D. C., home on April 20, was suggested at his funeral services by the Reverend Dr. John Van Schaick, who quoted from the Eighty-fifth Psalm: "Mercy and truth have met together."

Mr. Bailey, who had lived for almost 78 years, had devoted his most strenuous efforts to the advancement of knowledge about natural history and to the development of kindliness toward wild animals. Truth he honored and discovered in field investigations in every State of the Union and in Mexico and Canada, in studies that formed the basis for writings that are now listed in a bibliography of 244 titles. Mercy, in its most practical forms, he practiced through many years of work for conservation and gentle, patient, but persistent agitation, years that included his own accomplishments in designing and promoting the use of traps that make their captures "alive and unhurt."

The influences of such a character for good are, of course, inevitable, yet they were all the more effectively exerted by Mr. Bailey because by inclination he was a guide to other men and to women and boys and girls. Whether these influences, aside from those perpetuated within his writings, are considered as they were felt by other members of his profession, by the Boy Scouts of America, for whom he was a great leader, by his numerous audiences or only by his casual acquaintances and the general public, they must be valued most highly. As his colleague, Edward A. Preble, has pointed out, "even the ablest naturalists" had seen only by accident many of the small mammals that became well known when Vernon Bailey had discovered and shown others how these animals might be taken. Cumulatively in many other small ways Mr. Bailey changed the world in which he lived more than can be realized, and changed it for the better.

To many who knew him personally, and surely to some others also to whom he was known only at a distance, he will be remembered all the more preciously because of the companionship which, with the help of Florence Merriam Bailey, he created and perpetuated for forty years. The reassuring and enriching influences of this companionship have a precious reality for many who must now only remember it, but the remembrance is enduring and is most fittingly treasured up in the writings in collaboration that were among its benefits.

Rated since 1910 among the leading thousand of the country's scientists by "American Men of Science," Mr. Bailey had achieved his widest professional recognition as a mammalogist and an authority on the geographic distribution of mammals, birds and plants, yet the unqualified term "naturalist" was peculiarly appropriate to him. He was born on June 21, 1864, in Manchester, Mich., and at about the age of 6 moved with his pioneer parents to Elk River, Minn., where he laid the basis of his self-education in his own observations of natural history on his father's farm. It was the collection of specimens that he forwarded from there to Washington which led to his employment by Dr. C. Hart Merriam, founder of the agency that was later to become the Bureau of Biological Survey and the present Fish and Wildlife Service. First appointed as a special field agent in 1887, he soon became prominent among the corps of biologists then laying the foundations of a new governmental activity, and in 1890 he gained the title of chief field naturalist, which he cherished until his retirement in 1933 and which no other has had since. Practically every season of

his employment was marked by his field work in some part of the United States, including intensive biological surveys of Texas, New Mexico, North Dakota and Oregon, reported in the North American Fauna series, as well as many other studies described in shorter publications and in the popular articles he wrote so effectively for *Nature Magazine* and other periodicals. His colleagues considered his work in building up the Biological Survey's collections and files of information as especially noteworthy, though his writings made him known to more people. His contributions to the Biological Survey collection of mammals alone, included about 13,000 specimens, a large number of them new species. It was during the years of his government service that he designed and perfected the trap used widely in connection with beaver-stocking projects to capture the animals alive and unhurt, and also his foothold trap which he later improved for use on a variety of mammals and birds. For both of these traps he received prizes awarded by the American Humane Association, and after his retirement he did extensive work with and for that association.

"Retirement," however, was only a conventional term when used to describe the status of Vernon Bailey. The late Paul G. Redington, then chief of the Biological Survey, said of Mr. Bailey when he was freed from his official duties that he had "before him much productive effort in the sciences of ornithology and mammalogy and in the conservation and perpetuation of our valuable resources in wildlife." He was indeed right, for the remaining years were as notable as those that went before—in writing, in motion picture photography, in humane work, in lecturing and counseling and even in field work. At the time of his death Mr. Bailey was planning an expedition to Texas as a collaborator for the Fish and Wildlife Service.

His outstanding publications include "Beaver Habits and Experiments in Beaver Culture," "A Biological Survey of North Dakota," "Biological Survey of Texas," "Life Zones and Crop Zones of New Mexico," "Mammals of New Mexico," "The Mammals and Life Zones of Oregon," "Revision of the Pocket Gophers of the Genus Thomomys," "Cave Life of Kentucky" and "Animal Life of the Carlsbad Caverns." There were many others, among them the influential articles for general readers with such titles as "Dwellers in the Desert," "Humane Traps," "Ways of the Beaver People," "Animal Friends of the High Sierra" and "How to Become a Naturalist," and such notable collaborations with Mrs. Bailey as the volume on "Wild Animals of Glacier National Park," in which he wrote of the mammals and she of the birds.

Mr. Bailey was honored in many formal associations with his colleagues. He was a founder and past president of the American Society of Mammalogists, member of the American Ornithologists' Union, past president of the Biological Society of Washington, president of the Audubon Society of the District of Columbia, fellow of the American Association for the Advancement of Science, and member of the Cooper Ornithological Club, Washington Academy of Sciences, the American Forestry Association and other societies interested in wildlife and conservation. At the meetings of these organizations Mr. Bailey was always a focus of enthusiasm. His papers and comments never failed to rally attention, and his consideration for the younger members was for them an outstanding benefit of the meetings. His rich personality was one of the greatest inducements that one could feel toward a life devoted to science and conservation. Those who have known him well can surely hope that others in the future who will benefit by his contributions to science and the literature of the outdoors may also feel the personality of the man behind them.

HOWARD ZAHNISER

FISH AND WILDLIFE SERVICE,
WASHINGTON, D. C.

DEATHS AND MEMORIALS

JOHN WASHINGTON GILMORE, professor of agronomy at the College of Agriculture at Davis of the University of California, formerly president of the College of Hawaii, known for his work on soil management and field crop production, died on June 25, at the age of seventy years.

THE Medical Association of Georgia at its recent meeting in Augusta set aside, according to the *Journal* of the American Medical Association, $5,000 as a nucleus for a fund to construct the Crawford W. Long Memorial Building. The fund will be increased from year to year as the association directs. The building is a memorial to the late Dr. Long and will serve as the permanent headquarters of the association. This action marks the one hundredth anniversary of Dr. Long's discovery of anesthesia. Construction will begin when a suitable fund is available.

SCIENTIFIC EVENTS

THE SINGER WILDLIFE REFUGE

IN view of the threatened destruction of the Singer Game Refuge in Madison Parish, Louisiana, a correspondent requests us to print the following resolution passed some time ago by the Beta Mu Honorary Biological Fraternity of the Tulane University of Louisiana, New Orleans:

WHEREAS, The Singer Wildlife Refuge, located in Madison Parish, Louisiana, and comprising approximately 130,000 acres, is timbered with a virgin stand of hardwood forest and one of the few large stands of virgin cypress remaining in the south, and

WHEREAS, Specimens of such trees as the white elm, red gum, pecan and white oak contained therein are among the largest examples of these species to be found in the world, and

WHEREAS, This timbered area is one of the last known retreats of the almost extinct ivory-billed woodpecker, and contains the last known specimens in Louisiana of such other rare animals as the Louisiana cougar, the Texas coyote and black wolf, and

WHEREAS, The area abounds also in game animals such as the Louisiana black bear, wild turkey, deer, Louisiana grey squirrel, black fox-squirrel, upland game birds and the lakes provide sanctuary for migratory wildfowl, and

WHEREAS, The area has been very successfully maintained for the past twelve years as an inviolate refuge and sanctuary for wildlife, and

WHEREAS, Certain parts of the area have been leased for cutting, and the entire area is in danger of being sold for timber so that not only will this incomparable stand of big trees be lost forever, but also the rare animals be driven to extinction,

Therefore be it Resolved, by the Beta Mu Honorary Biological Fraternity of Tulane University in regular meeting on February 14, 1939, that it does hereby approve, recommend and urge that legislation be enacted by federal or state authorities or both to prohibit lumbering or other pursuits, which will destroy or impair the value of this area either as an untouched forest, or as a wildlife refuge, and that said area be permanently preserved as an inviolate natural area, and be it further

Resolved, that copies of this resolution be sent to the United States Senators from Louisiana.

THE SEGREGATION OF BLOODS

THE Committee on Race Relations of the American Association of Physical Anthropologists is opposed to the segregation of the bloods from White and Negro donors in the blood banks which are being collected under the auspices of the American Red Cross. The committee's reasons for opposing it are the following:

1. There is no evidence that the blood of Negroes differs in any significant respect from that of Whites. The successful transfusion with whole blood from Whites to Negroes or *vice versa* can be accomplished quite as readily as between members of the same race. The same blood groups occur among both Whites and Negroes and no difference has been demonstrated between White and Negro bloods of the same groups.

In the form of dried serum or plasma in which the blood currently collected is being stored, even differences in blood group between donor and recipient are of no consequence.

2. One objection to the indiscriminate use of Negro blood in the blood bank is the somewhat higher incidence of syphilis among them and the erroneous notion that the disease can be transmitted by means of dried blood of a luetic donor to a non-luetic recipient.

(a) Every blood sample received is tested for evidence of syphilis and all found to react positively are rejected.

(b) Procedures used in preparing and preserving the dried blood plasma or serum would kill any syphilitic organism in the blood, even if, as might conceivably happen, the blood of a syphilitic donor were inadvertently included in the blood bank.

3. The segregation of the blood of Whites from the blood of Negroes in the blood bank is, therefore, not only unscientific, but it is a grievous affront to the largest minority group in our country. This policy of the American Red Cross appears even more indefensible when one considers the origins of some of the substances which are widely and effectively used in modern medical practice and which are readily accepted by the patient.

(a) The use of materials obtained from the blood of horses, rabbits and other animals for protecting against or combating various diseases, such as diphtheria, pneumonia, etc.

(b) Many of the estrogenic (female sex hormone) and gonadotropic preparations currently used in therapy are obtained from the urine of stallions and from the urine or blood serum of pregnant mares. Their efficacy is in no way impaired by their rather inauspicious origin.

(c) The use of extracts or concentrates of various animal organs in the treatment of certain human diseases has been accepted gratefully and with much benefit by those afflicted with such diseases as pernicious anemia, hypo-thyroidism, diabetes mellitus, Addison's disease, etc.

The members of the Committee on Race Relations of the American Association of Physical Anthropology are:

Dr. William K. Gregory, curator, department of comparative anatomy, American Museum of Natural History, and president of the American Association of Physical Anthropologists.

Dr. Harry L. Shapiro, assistant curator, department of physical anthropology, American Museum of Natural History.

Dr. Franz Weidenreich, formerly of Peking Union Medical School, Peking, China, now working at the American Museum of Natural History.

Dr. W. W. Greulich, professor of physical anthropology and anatomy, Western Reserve University Medical School, director of the Brush Foundation, *Chairman*.

ADDITIONS TO THE MEDICAL PROFESSION

THE *Journal* of the American Medical Association calls attention to the fact that perhaps the most accurate index of actual additions to the medical profession of the United States is to be found in the medical licensure statistics collected by the Council on Medical Education and Hospitals of the American Medical Association and published annually in its State Board Number. It is stated that the number of graduates of the medical colleges of the United States includes a certain number of students from

foreign countries and does not include students from the United States graduating from Canadian medical schools. Neither does it indicate the graduates of the foreign medical schools who initiate practice in the United States. The data indicate that there were 5,681 additions to the medical profession in 1941. The number lost to the profession each year by death is approximately 3,700. There has thus occurred during 1941 a net increase of approximately 1,900 in the number of physicians in the United States. Of these 5,681 newly licensed physicians, 626 were graduates of foreign medical schools and 226 were graduates of unapproved medical colleges in the United States. During 1941, there were 4,738 graduates of approved medical colleges. Accumulated data indicate that during the past seven years there have been 41,983 new additions to the profession. As a result of increase in the number of students admitted and the adoption of an accelerated curriculum by most of the medical colleges, the annual additions to the profession from the medical schools of this country should increase by more than 25 per cent. during the next few years.

GRADUATE COURSES GIVEN AT THE SUMMER SESSION OF COLUMBIA UNIVERSITY

INCLUDED in the summer courses of Columbia University for the six-week session from July seventh to August fourteenth, attention may be called to the following:

Recent Developments in Physical Chemistry: This will survey such important subjects as isotope separation and uses, atomic disintegrations, high molecular weight polymers with applications to biology and plastics, and the theory of absolute reaction rate with applications to a variety of physical phenomena.

Computational Techniques: Courses are offered to provide the student not only with supervised practice in the more elementary calculations involved in physical chemistry but with the opportunity to acquire skill in such calculations as, for example, those involved in obtaining potential energy surfaces for molecular systems and in determining thermodynamic quantities from spectral data —the particular topics will depend on the interests and previous training of the individual student.

New Methods in Experimental Physical Chemistry: The laboratory of physical chemistry has been re-equipped recently. In addition to the regular graduate course in experimental physical chemistry, there will be opportunity for experimental work with such apparatus as the polarograph, a variety of spectrographs and colorimeters and the vacuum tube electrometer.

Special Topics in Experimental Organic Chemistry: Again, in addition to the usual graduate courses in experimental organic chemistry, opportunity will be given for special training which might include high pressure hydrogenation; chromatographic adsorption; isolation of such natural products as alkaloids, proteins, enzymes and the use of special apparatus.

Food Chemistry: Two courses will be offered, one a lecture course in food and nutrition and the other a laboratory course in food analysis specializing in chemical methods for the vitamins, including the use of the fluorophotometer and abridged spectrophotometer.

THE BUFFALO MEETING OF THE AMERICAN CHEMICAL SOCIETY

DR. NELSON ALLEN, supervisor of research in the Cellophane research section of E. I. du Pont de Nemours and Company, Buffalo, N. Y., has been named general chairman of the one hundred and fourth national meeting of the American Chemical Society, to be held in Buffalo from September 7 to 11. The contributions of chemistry to the war effort through research in vital materials and through the development of speeded-up industrial processes will provide the principal subject of the meeting, which, it is expected, will be attended by more than 4,000 chemists and chemical engineers from industrial, government and university laboratories.

Seventeen of the eighteen professional divisions of the society will meet at Buffalo and seventy-two sessions are planned. The Division of Petroleum Chemistry, the only one not meeting there, was forced to cancel its sessions because of the pressure of war work on its members.

Chemical aspects of food preservation by canning, dehydration and refrigeration will be the subject of a special symposium to be held by the Division of Agricultural and Food Chemistry. Another symposium of this division will be devoted to discussion of the processing of foods for the military forces and protection of food against war damage. A joint session of the Divisions of Agricultural and Food and Biological Chemistry will center on new developments in vitamins and proteins.

Dr. Ellery H. Harvey, consultant chemist, of Chicago, is chairman of the Agricultural and Food Division, and Dr. Ben H. Nicolet, of the U. S. Department of Agriculture, of the Biological Division.

Research in rubber and rubber substitutes will be discussed at four sessions of the Division of Rubber Chemistry, presided over by Dr. John N. Street, manager of the research division of the Firestone Tire and Rubber Company, Akron. Uses of coal by various industries will be discussed by the Division of Gas and Fuel Chemistry, of which Dr. Orin W. Rees, of the Illinois State Geological Survey, is chairman.

Dr. R. Norris Shreve, of Purdue University, will preside at a symposium on unit processes to be held by the Division of Industrial and Engineering Chemistry. "Administrative Problems of the Research Laboratory" and "The Manufacture and Use of Solvents" are other special topics in the discussions of this division, of which Dr. Lawrence W. Bass, assistant director of the Mellon Institute, is chairman.

Recent developments in drying oils will be the principal theme of the Division of Paint, Varnish and Plastics Chemistry, headed by Dr. Shailer L. Bass, of the Dow Chemical Company, Midland, Mich. The Divisions of Chemical Education and of Analytical and Micro Chemistry will hold a joint symposium on the "Teaching and Practice of Analytical Chemistry."

Wartime chemical research in medicine, water, sewage and sanitation, colloids, cellulose, sugar and fertilizers will be reported and discussed. Sessions on the history of chemistry, organic chemistry and physical and inorganic chemistry will also be held. Because of industrial regulations made necessary by the war, trips to plants in the convention city area, long a regular feature of the meetings, will not be arranged this year.

The executive committee in charge of arrangements for the convention includes, in addition to Dr. Allen, Dr. J. F. Walker, Jr., of the R and H Chemicals Department of E. I. du Pont de Nemours and Company, Niagara Falls; W. H. Koch, of the Mathieson Alkali Works, Niagara Falls; Professor H. W. Post, of the University of Buffalo; Dr. Hans O. Kauffmann, of the Buffalo Electrochemical Company; and Lawrence H. Flett, of the National Aniline and Chemical Company, Buffalo.

SCIENTIFIC NOTES AND NEWS

AT a special convocation to dedicate the new building of Northwestern Technological Institute, Northwestern University awarded the honorary degree of doctor of science to Dr. Roger Adams, chairman of the department of chemistry of the University of Illinois; Acting President Robert C. Disque, of the Drexel Institute of Technology; to Alexander D. Bailey, chief operating engineer of the Commonwealth Edison Company; to Dr. Paul E. Klopsteg, president of the Central Scientific Company; and to Alfred H. White, chairman of the department of chemical engineering of the University of Michigan. The honorary degree of doctor of laws was conferred on Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, and on Dr. Henry T. Heald, president of the Illinois Institute of Technology.

THE John Phillips Memorial Medal of the American College of Physicians has been awarded jointly to the late Dr. James D. Trask and to Dr. John R. Paul, associate professor of medicine at the School of Medicine of Yale University.

THE degree of doctor of science was conferred at the commencement exercises of Huntington College, Indiana, on Fred A. Loew, professor of biology and geology at the college and founder and director of the arboretum and botanical garden.

MOUNT UNION COLLEGE, Alliance, Ohio, conferred at commencement the degree of doctor of science on Dr. Howard Bancroft Andervont, senior biologist in cancer research of the U. S. Public Health Service.

NEWLY elected officers of the Mayo Foundation Chapter of Sigma Xi are: *President,* Dr. A. C. Broders; *Secretary,* Dr. R. K. Ghormley; and *Treasurer,* Dr. H. E. Essex.

OFFICERS of the Royal Society of South Africa are reported in *Nature* to have been elected as follows: *President,* Professor A. Brown; *Honorary Treasurer,* Professor R. W. James; *Honorary General Secretary,* Dr. A. J. H. Goodwin; *Honorary Editor of the Transactions,* Dr. A. L. Du Toit; *Honorary Librarian,* Professor E. Newbery.

DR. CARL E. SEASHORE, research professor of psychology at the State University of Iowa and for twenty-eight years dean of the Graduate College, has been appointed interim dean of the college until a successor is found to Dr. George D. Stoddard, who resigned recently to become New York State Commissioner of Education.

DR. F. J. ALWAY, of the University of Minnesota, having reached the retirement age, was made on July 1 professor emeritus in the Division of Soils, after having served twenty-nine years as chief of that division. He is succeeded by Dr. Clayton O. Rost, who, in 1913, went with him to Minnesota from the University of Nebraska.

DR. FRANK M. SIMPSON, professor of physics at Bucknell University and chairman of the department, retired on July 1 with the title emeritus. He has been associated with the university for a period of forty-two years, for thirty-five years as professor and head of the department of physics.

DR. ROBERT F. PITTS has been appointed assistant professor of physiology, Cornell University Medical College, beginning on July 1. He was previously assistant professor of physiology at the New York University Medical School.

DR. CHARLES H. JUDD, emeritus professor of education and director of the department of psychology at the University of Chicago, will be a member of the staff of the summer session of the University of California at Berkeley.

THE following have been promoted to full professorships at the University of Michigan: Dr. Cecil

Calvert Craig, mathematics; Dr. Lee Raymond Dice, zoology, and Dr. Albert B. Peck, mineralogy.

DR. LOREN C. EISELEY has been promoted from assistant to associate professor of anthropology at the University of Kansas. Under a research grant from the university, he will work this summer at the American Museum of Natural History in New York City, completing a project in physical anthropology undertaken during a post-doctoral fellowship awarded to him in 1940–41 by the Social Science Research Council.

DR. WILLIAM BARRY WOOD, JR., associate in medicine at the School of Medicine of the Johns Hopkins University, has been appointed Busch professor of medicine at Washington University School of Medicine, St. Louis, to succeed Dr. David P. Barr, who resigned last year to accept a similar position at the Cornell University Medical College, New York.

DR. DONALD DUNCAN, associate professor of anatomy in the faculty of medicine of the University of Texas, Galveston, has been appointed professor and head of the department of anatomy at the School of Medicine of the University of Buffalo.

DR. LAURENCE L. QUILL, of the Ohio State University, has been appointed chairman of the department of chemistry in the University of Kentucky. He succeeds Professor Ralph N. Maxson, who has requested to be relieved of administrative work but who will continue to teach.

DR. FLORENCE PEEBLES, since 1928 professor of biology at Chapman College, Los Angeles, has been appointed director of the biological laboratory of Albany College, Portland, Ore.

WESTERN RESERVE UNIVERSITY announces a reorganization of the department of chemistry. Dr. Harold Simmons Booth, professor of chemistry, has been appointed chairman of the department. Dr. Frank Hovorka, formerly associate professor, has been promoted to a professorship and made director of the university chemical laboratories. Dr. Herman Peter Lankelma, formerly associate professor, has been promoted to a professorship of chemistry and made secretary of the department. Dr. Robert E. Burk, professor of chemistry, has been assigned to the responsibility of special departmental projects. Dr. Oliver Grummitt, instructor in chemistry, has been promoted to an assistant professorship. Two new members appointed to the staff are Dr. William Kieffer, of Wooster College, and Dr. Terrell Hill, of the University of California.

RECENT appointments in the Office of the Medical Division of the Office of Civilian Defense include Dr. Henry N. Hooper, superintendent of the Cincinnati General Hospital, who has been appointed consultant in hospital administration; Dr. Victor H. Vogel, assistant chief of the Division of Mental Hygiene of the U. S. Public Health Service and passed assistant surgeon of the Public Health Service, who has joined the staff, and Carl E. Schwob, Chicago, who has been appointed sanitary engineer (Reserve). In September, 1939, Mr. Schwob was loaned by the state health department to the department of welfare as assistant managing officer at the Manteno State Hospital, Illinois, in charge of typhoid control during and following a serious epidemic at the hospital.

DR. HOMER FORDYCE SWIFT, a member of the Rockefeller Institute for Medical Research since 1922, a specialist in the treatment of the central nervous system, has been elected for a four-year term a member of the New York University Council under a plan instituted three years ago which is designed to foster broader alumni participation in the direction of the institution.

THE Tennessee Products Corporation has established at Vanderbilt University a fellowship in chemical engineering. William K. Lautner has been made fellow and plans to make a study of wood distillation tars.

SIR HENRY H. DALE, president of the Royal Society, will retire from the post of director of the National Institute for Medical Research on September 30. To succeed him the Medical Research Council has appointed Professor C. R. Harington, F.R.S., who is at present professor of chemical pathology in the University of London and director of the Graham Medical Research Laboratories of University College Hospital Medical School.

EMMET R. BLAKE, the ornithologist and South American explorer, who has been assistant curator of birds on the staff of Field Museum of Natural History since 1935, has been inducted into the United States Army. He is the nineteenth member of the staff to have leave of absence for war service. Sixteen of these are in the Army, Navy and Marine Corps, one is in the merchant marine and two are in government civilian posts connected with the prosecution of the war. Of the nineteen, three—Brigadier-General Theodore Roosevelt, Lieutenant-Commander Lester Armour and Naval Lieutenant Joseph Nash Field—are trustees of the museum; the other sixteen are employees, ranging from museum guards to scientific men. They include the director of the museum, Lieutenant-Colonel Clifford C. Gregg.

THE forty-eighth summer meeting and twenty-fourth Colloquium of the American Mathematical Society will be held at Vassar College on September 8, 9 and 10 in conjunction with the summer meeting

of the Mathematical Association of America and the Institute of Mathematical Statistics. Sessions of the society will begin on Tuesday morning at 9 A.M. and continue through Thursday. Sessions of the association will be held at 10 A.M. and 2 P.M. on Monday and those of the institute on Monday, Tuesday and Wednesday. The twenty-fourth colloquium will consist of four lectures on "Topology of Manifolds" by Professor R. L. Wilder, of the University of Michigan. These lectures will be given at 9 A.M. on Tuesday, Wednesday and Thursday and at 2 P.M. on Thursday. At 2 P.M. on Wednesday, there will be an address on "Transformations with Periodic Properties" by Professor W. L. Ayres, of Purdue University. At 3:15 P.M. on Wednesday, a symposium on statistics as related to the war effort will be held jointly with the Institute of Mathematical Statistics. The council will meet on Tuesday evening at 8 P.M. There will be a dinner for the mathematical organizations at 6:15 P.M. on Wednesday, followed at 8:30 by a concert. There will be a tea given by the department of mathematics of Vassar College on Monday afternoon. An excursion to Lake Mohonk is being planned for Tuesday afternoon.

Nature reports that the following have been elected presidents of the various sections of the 1943 session of the Indian Science Congress, to be held in Lucknow during January 2–8, 1943. The fourteen sections into which the congress originally divided its work have been regrouped into twelve sections: *Mathematics and Statistics,* Dr. S. C. Dhar, University of Nagpur; *Physics,* Dr. H. J. Bhabha, Indian Institute of Science, Bangalore; *Chemistry,* Dr. S. S. Joshi, Benares Hindu University; *Geology and Geography,* Lieutenant-Colonel E. A. Glennie, Survey of India, Dehra Dun; *Botany,* Dr. K. Biswas, Royal Botanical Garden, Sibpur, Calcutta; *Zoology and Entomology,* Dr. B. N. Chopra, Zoological Survey of India, Calcutta; *Anthropology and Archeology,* Dr. N. Chakravarti, Archeological Survey of India, New Delhi; *Medical and Veterinary Sciences,* Dr. F. C. Minett, Imperial Veterinary Research Institute, Mukteswar; *Agricultural Sciences,* Rao Bahadur Y. Ramchandra Rao, Imperial Council of Agricultural Research, New Delhi; *Physiology,* Dr. B. Narayana, P.W. Medical College, Patna; *Psychology and Educational Science,* Dr. B. L. Atreya, Benares Hindu University; *Engineering and Metallurgy,* Professor K. Aston, Indian Institute of Science, Bangalore.

COLIN C. SANBORN, curator of mammals of Field Museum of Natural History, recently returned to Chicago after nearly nine months of zoological collecting in Peru. He obtained some four hundred specimens of mammals, approximately nine hundred reptiles, three hundred fishes, a hundred birds and numerous insects. A large part of these were successfully shipped to the museum prior to January; the balance of the collections are temporarily stored at Callao. The collections, together with previous collections, give Field Museum the largest representation of the fauna of southern Peru ever brought out of that country. The Peruvian Government, the University of San Marcos at Lima and the Museo Javier Prado, connected with the university, gave their hearty cooperation. Enrique Zoniga, a member of the staff of the Javier Prado Museum, spent several months with Mr. Sanborn in the field, collecting specimens on the southern coast of Peru and in the jungles of the eastern part of the country.

ACCORDING to *Chemical and Engineering News,* a cooperative arrangement has been effected between the U. S. Bureau of Mines, the Chemical Warfare Service and the University of Maryland whereby work on problems relating to extinguishing incendiaries will be done at the War Department Civilian Protection School at College Park, Md.

THE organization is announced by *The New York Times* of special forestry Army units. These units will be trained as combat field troops to perform "such tasks as the procurement of lumber and timber for military operations. Officers have been selected from rosters of highly qualified foresters, loggers and sawmill men, while the enlisted men will be qualified woodsmen and sawmill men."

ACCORDING to an Associated Press dispatch dated from Albany on June 24, public subsidies for the liberal arts colleges and secondary schools of New York are being considered by the State Education Department. It is stated that the question of the ability of liberal arts colleges to carry on with private funds produced a "unity of belief that great difficulties lie ahead, both during and after the war." Members of a committee appointed to draw up a program are Dr. Harry Woodburn Chase, chancellor of New York University; Dr. Edmund E. Day, president of Cornell University; Dr. Dixon Ryan Fox, president of Union College; the Very Rev. Thomas Plassmann, president of St. Bonaventure's College, and Dr. Alan Valentine, president of the University of Rochester.

THE British Standards Institution has been recognized by the government as the sole organization for the issue, in consultation with any government, professional or industrial bodies concerned, of standards having a national application. In regard to the preparation and issue of codes of practice for building and civil engineering work, the Minister of Works and Buildings is making special arrangements by the appointment of a representative committee with which the institution is cooperating.

DISCUSSION

THE FOUR-FOLD TABLE AND THE HETEROGENEITY TEST

IN a recent issue of SCIENCE the interpretation of observations in a four-fold table has been discussed by E. B. Wilson,[1] and later some critical remarks to this discussion have been made by R. A. Fisher.[2] Wilson considers two samples of mice into each of which two different viruses have been injected with a result which may be written so:

	Died	Lived	Total
Sample 1	a	b	$a+b$
Sample 2	c	d	$c+d$
Total	$a+c$	$b+d$	n

The difficulty met by him is that, using different methods of analysis, he arrives at different grades of significance of the difference in death rate between the two samples. As Fisher points out, the reason is that Wilson assumes some plausible value for the death rate as known to be true ($\frac{1}{2}$ in his case). Therefore Fisher recommends the method known as "Fisher's Exact Method,"[3] since the probability P in this case is independent of the true death rate. (This independence is, however, probably only assured when applying method I, below, for the measurement of the discrepancies between the two observed samples). The cause of this independence is that of the $(a+b+1)(c+d+1)$ possible combinations of two samples with the given *sample* totals, $a+b$ and $c+d$, only those combinations having the same *marginal* totals, $a+b$, $c+d$, $a+c$ and $b+d$ are selected by Fisher as a sufficient base for the comparisons. It seems, however, that the primary base of legitimacy of this procedure of selection is that it makes the probability P independent of the unknown, true proportion p. In the following lines, therefore, it is assumed that it is necessary to compare all possible combinations of two samples having the given *sample* totals.

But other difficulties arise. The biologic question is, if the two samples may have been drawn from a common population; or, in other words, if a proportion p may, at least theoretically, be determined, such that, taking this proportion as the true one, the value of the probability P is greater than some at beforehand assigned level of significance. The number P is always made up of the sum of the probabilities of all separate combinations of two samples for which the discrepancy is as great as or greater than that in the observed two samples (in one or both tails). Therefore the first difficulty arises when choosing among different ways of measuring this discrepancy. Many such ways are possible, but consider the following three: I. The arithmetic difference between the proportions in the two samples. Greater difference means greater discrepancy. This method is used in the cited articles by Wilson and Fisher. II. The probability of the separate combinations of two samples. Smaller probability means greater discrepancy. III. χ^2 of the separate combinations of two samples. Greater χ^2 means greater discrepancy. Method I is simplest, but its logic is questionable, since it is not applicable to tables with more than two classes in each sample. When applying methods II and III, however, the answer to the question, if the probability of a certain combination of two samples is to make part of P, is dependent on the value of p.

Another difficulty is to settle which estimate of p is to be looked upon as the "best" one. Usually the maximum likelihood solution $p=\frac{a+c}{n}$, which makes the probability of the separate observed combination of the two samples to a maximum, is taken as the best one. By minimizing χ^2 we get the estimate $p=\frac{k}{1+k}$, where

$$k^2=\frac{a^2(c+d)+c^2(a+b)}{b^2(c+d)+d^2(a+b)}.$$

As a rule, however, none of these estimates gives a maximum value to P.

As a very simple example, take the four-fold table

			Total
Sample 1	0	2	2
" 2	2	1	3
Total	2	3	5

The maximum likelihood estimate is $p=.4$ and the minimum χ^2 estimate is $p=.4305$. For these and some other values of p Table 1 has been worked out.

TABLE 1

p	Probability of the separate observed combination of the two samples	χ^2 of the separate observed combination of the two samples	Probability P when the discrepancy is measured according to method		
			I	II	III
.39	.1036	2.2440	.2264	.3904	.3904
.40	.1037	2.2222	.2304	.4989	.3952
.41	.1036	2.2068	.2341	.4999	.4005
.4305 ..	.1027	2.1943	.2404	.5035	.5035
.45	.1011	2.2054	.2450	.5089	.5089
.50	.0938	2.3333	.2500	.6250	.6250
.55	.0827	2.6094	.2450	.4079	.3255
.60	.0691	3.0556	.2304	.2138	.2915

In the computation of P in Table 1, both tails have been taken as parts of P. Applying Fisher's "Exact Method" we get $P=.4$, if both tails are added, but $P=.3$ if (as Fisher himself always seems to do) only the tail of the same side as the observed samples is taken into account.

[1] E. B. Wilson, SCIENCE, 93: 557–560, 1941.
[2] R. A. Fisher, SCIENCE, 94: 210–211, 1941.
[3] R. A. Fisher, "Statistical Methods for Research Workers" (Section 21.02), Oliver and Boyd, Edinburgh, 1925–1941.

It is clearly seen that for the $p:s$ chosen, $p = .50$, though greater than the maximum likelihood estimate, gives maximum value to P, whatever method used. All values of P in this example are far above the usual levels of significance. But cases may well occur where P falls short of such a level when the maximum likelihood or the χ^2-minimum estimate is used, though P may be greater than the level for other values of p, and that thus the two samples may have been drawn from a common population.

It may finally be pointed out that difficulties of quite the same kind occur when dealing with tables of higher rank than the four-fold, especially when making heterogeneity tests. It is only the limitation of available methods which is the defense of our mode of attacking the problems.

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A NEW THEORY OF THE ORIGIN AND NATURE OF LIFE[1]

OF the numerous theories which have been proposed to account for the origin of life nearly all have been hypothetical reconstructions based on biochemical considerations, but unsupported by laboratory demonstrations linking the implied syntheses with the genesis of specific structural entities which simulate, both in appearance and in behavior, forms already known to the biologist. After devoting forty-three years to the experimental investigation of this problem, I have been able to produce two principal groups of phenomena which appear to me to be significant:

1. *Colpoids.* Mix thoroughly 200 cc of very fresh, pure olive oil with 800 cc of clear, pure gasoline. Place the mixture in a flat-bottomed container (a tray of the sort used to develop photographic negatives is advantageous) and add, drop by drop, a solution of pure sodium hydroxide (12 g to 100 cc) to which has been added a gram of hematoxiline to serve as a stain. The resulting macroscopic cells exhibit lively ameboid movement, intracellular streaming and fission. Their activity is inhibited by chloroform. We are dealing here with saponification activated by osmotic currents and electric disturbances set up by the chemical reaction, but the parallel with overt phenomena of life on the protozoan level is so striking that one is compelled to seek identical explanations. This experiment was presented a number of years ago at a session of the New York Microscopical Society by Dr. C. W. Weiant and more recently was exhibited in motion pictures before the Congress of Biophysics in New York.

2. *Sulphobes.* Taking it for granted that formaldehyde is an essential stage in the synthetic activity of green plants, I made a methodical study of the action of reagents on formaline. The fumes of ammonium sulfide acting upon thin layers of formaline produce many of the structural aspects of protoplasm. Since, according to Pflügger, life is due to cyanogen and its derivatives on up to the proteins, I decided to dissolve ammonium thiocyanate in formaline, spread the material in very thin layers, and then waited several hours before making a microscopic examination. I have repeated this experiment, under varying conditions, for a period of ten years, thereby obtaining thousands upon thousands of microscopic structures with activities analogous to those of living organisms.[2] Chemical products include vestiges of starch, at least two amino-acids, a condensation product of protein character and globules of green, yellow and red pigments. The latter substances I am now investigating. They do not manifest absorption rays in the spectrum, perhaps because present in such minute quantities. Structures noted comprise cell, ameba and tissue forms of infinite variety, imitating virtually the whole microscopic world. More than 6,000 varieties, among them the counterparts of diatoms, spermatogonia, spores, chromosomes and astrospheres, direct and mitotic divisions, plasmodia, etc., have been recorded and published during the past ten years. I have sent to foreign scientists and scientific institutions more than 900 specimens preserved in Canada balsam and will gladly send additional samples without cost to any interested inquirer.

Now let it be remembered that it is possible to synthesize the thiocyanate used in these experiments by subliming sulfur in a matrass with ammonium nitrate and carbon. Sulfur alone sublimed on cold glass yields no end of cellular patterns, by virtue of its molecular polymorphism and resulting allotropic states. In view of these facts, may it not be that the emanations from volcanoes—sulfurous, cyanic and ammoniacal—have produced and continue to produce microorganisms by chemical synthesis? I intend to study the sublimates of the solfataras of Popocatepetl from this standpoint. Sulfur is present in nearly all proteins and in all living organisms and thus merits special attention in any theory of the origin of life. The particular theory offered here of course lacks confirmation. Much further research is required for that, but it is a theory which, up to a certain point, finds laboratory corroboration. It is itself the outgrowth of experimental method.

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[1] Translated by C. W. Weiant.

[2] See *Bulletin du Laboratoire de Plasmogenie,* Vol. I, and Vol. II now appearing.

SUPPOSED EXTINCT MAPLES

IN A. P. Coleman's posthumous publication, "The Last Million Years,"[1] which is a history of the Pleistocene in North America, the statement is made on page 189 that "as for the trees, only four interglacial species have been reported as extinct, two maples (*Acer pleistocenicum, A. torontoniensis*), a locust tree (*Gleditschia donensis*) and a tamarack (*Larix churchbridgensis*), and these seem closely related to modern trees, one of the two species of *Acer* being probably the ancestor of our existing sugar maple." These species, with the exception of *Larix churchbridgensis*, which is from Manitoba, were described by D. P. Penhallow[2] from the noted fossiliferous interglacial beds of the Don Valley at Toronto. Associated with them, according to Penhallow, are: *Picea nigra, Populus grandidentata, Quercus alba, Ostrya virginiana, Ulmus americana, Maclura aurantiaca, Carya alba, Platanus occidentalis, Prunus* sp., *Robinia pseudacacia, Cercis canadensis* and *Tilia americana.*

It would not be surprising to find maples among such an assemblage, but the illustrations given by Penhallow, and repeated by Coleman, of the type specimens of the supposed extinct maples are not those of maples but of variant leaves of the plane-tree or sycamore, *Platanus occidentalis*, a species already listed as being present in the Don Valley collections. That these maples are in fact sycamores is corroborated by Penhallow's description of *Acer torontoniensis*. Of these leaves he says: "Two principal veins extend from the base of the midrib to the corresponding lobes, and two subordinate veins of varying prominence extend diagonally downward from near the same point into the two minor and variable lobes which form the base of the leaf blade." The last clause gives the clue to the distinction between full-formed, typical maple and sycamore leaves. In palmately-veined maple leaves all the strong primary veins and an occasional pair of lesser veins radiate from the same point at the top of the petiole. In sycamores, however, only two primary lateral veins arise from the top of the petiole; but from each primary, a short distance from the top of the petiole, a strong secondary vein branches into the lower lobe of the leaf.

An inspection of Coleman's upper illustration on page 188, which is a reproduction of one from Penhallow, shows the strong secondaries branching from the primaries at about a half inch from the top of the petiole. The basal sinus of this leaf also is platanoid, with the margin concave inward, rather than convex outward, as it would be in maples. The marginal teeth on the fossils are not well-preserved and could perhaps be duplicated in some living maples. They can be matched readily in *Platanus*. In view of the misidentification to which attention is called here, and in order to avoid further perpetuation of this error, the names of the two supposed extinct maples should be stricken from fossil plant lists.

The writer has not seen specimens or illustrations of *Gleditschia donensis* and *Larix churchbridgensis* and therefore has no opinion as to their status.

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[1] University of Toronto Press, Toronto, Canada, 1941.
[2] D. P. Penhallow, *Am. Nat.*, 41: 443–452, 1907.

THE OBJECTIVES OF THE SCIENTIFIC SPEAKER

IN the May 15 issue of SCIENCE, Mr. Potter, in his enthusiasm for popular presentation, seems to overlook the primary purposes of the scientific meeting. In taking a place on the program of such a meeting, a scientist, who is actively engaged in research, has two objectives in mind. First, it gives the opportunity to publish in the proceedings of the society, at least in abstract, and thus to establish the priority of his work; second, he presents his methods, results and conclusions to workers in the same or related fields in the hope that he will receive some help in the form of well-considered criticism.

The position of the speaker on such a program is difficult. He is faced with the problem of presenting in 15 minutes the results of several months' work and do it in such a way that his audience can get a sufficiently complete picture of what has been accomplished to enable them to judge correctly of its merits. To do this he must use technical terms because of their concise and exact meanings, and since his audience consists of workers in the same field such use is expected and requires no apology. All that a popular science writer can expect to get from such a talk, unless he happens to have been trained recently in the same science, is to determine whether or not the work is of such a character that it can be put into a form that will have popular appeal. If so, he should interview the speaker later and secure the necessary background for his story.

Mr. Potter's error is in assuming that the scientist is under an obligation to present his work in popular form. It is the popular science writer rather than the scientist who is supposed to be expert in the use of popular language and to know what will appeal to the public. The science writer, in training himself to fulfil this function, must acquire a broad scientific vocabulary and a real interest in science in addition to a facility in putting scientific facts into a form that will interest and instruct the general public.

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SPECIAL CORRESPONDENCE

THE FULL UTILIZATION OF SCIENTIFIC PERSONNEL

WE are repeatedly told that this is a *technical* war, waged primarily with scientific weapons and appliances whose design, construction and use require the cooperation of men specially trained as scientists, engineers or physicians. To put more such men at the disposal of their country, curricula are speeded up. Draft deferments are granted so that students may complete what is regarded as essential training in the basic sciences or special techniques. In all these plans there is evidence that the government and the scientific professions realize the importance of highly trained "fighters" and equally specialized "ground crews" to keep the scientific part of the military machine rolling.

Yet there is a patent failure to enlist the volunteer services of hundreds of young scientists who, as teachers or research workers, at this late date are still not engaged in scientific work that relates to the war. Many continue at peaceful and non-essential research, though impatient for direction into more useful service. If exempt from service in the armed forces because of their positions or sex, they feel themselves useless to the war effort in spite, and in fact almost *because,* of their special training. They are driven to taking appointments as airplane spotters or fire wardens, wholly laudable pursuits for any citizen in wartime but calling for no more specialized scientific background than a strictly military assignment "in the line." This seems to have proven especially true for all scientists whose work lies outside the fields of physics and mathematics. Most biologists and geologists and a large number of chemists are not being fully utilized to date.

Another group, of which several illustrations are known to the writers, that is not being fully utilized is that of the scientists who have retired or are approaching retirement from university activity because of compulsory age limitations. One physicist writes, "I am strong and well and able to work long hours and able to work anywhere. In this emergency when scientific men are needed so badly, I do not feel that I should sit and hold my hands. I do not need a job for the sake of a job, but I do wish to help in work that needs to be done and where it is difficult to find men to do it."

It is entirely understandable that a large nation takes time to get in motion. No one should be blamed for this failure to mobilize immediately and to the full the latent energy, enthusiasm and training of our younger and older scientists. But the need for their help grows rapidly, and certainly the trained men and women are available.

No coordinating agency has been set up for this purpose. The National Roster of Scientific and Specialized Personnel functions, quite properly, chiefly as a catalogue of available individuals; it does not initiate projects or stimulate the inventive ability of others. Should not the older scientists, now in positions of responsibility and command; the more distinguished members of the American Association for the Advancement of Science; and those engaged in formulating the war plans of the National Academy of Sciences and the O.S.R.D. give careful thought to this problem of mobilization on the scientific front? One helpful approach, readily accessible to the senior scientists, would consist of stimulating the younger workers to exercise their initiative in formulating and participating in suitable wartime research projects. A knowledge of the large number of available persons not now utilized would be necessary for this purpose and the A.A.A.S. might well issue a brief questionnaire through its *Bulletin.*

In a recent report on the state of civilian morale in the combatant nations, some one wisely remarked that morale rose in direct proportion to participation in the struggle. We lower morale among our intellectual workers when we frustrate their wishes and their efforts. But worst of all, we lose services that are now sorely needed. The problem of mobilizing the younger and less well-known group of scientists has scarcely been touched to date. If the war is to be prosecuted with the utmost vigor, this is a personnel problem of outstanding importance to our success in the stern months ahead.

The American Association of Scientific Workers, nationally and through its local branches, is carrying on various activities designed to further the mobilization of scientists.[1] However, from the experience of the New York branch of the association and from the observations of the signers of this report, who are themselves engaged in war research, the full utilization of our country's resources in scientific and technical personnel requires decisive action by our national scientific authorities and by our senior scientists.

CHAS. H. BEHRE, JR.
HARRY GRUNDFEST
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[1] See report in "Biology and Medicine in the War," SCIENCE, 95: 2472, 507–508, May 15, 1942.

QUOTATIONS

PUBLIC HEALTH IN GERMANY

THE *Nieuwe Rotterdamsche Courant* of April 14 writes that there must be a drastic overhauling of the methods of training physicians. "The whole medical education must be revised and given another spirit. The medical problem is not the treatment of a sick individual, dissociated from his environment, but the combating of the illness of a member of the community, which is paid by the community, ordered by the community and responsible to the community. The state can not allow such an important class as the medical class, which holds in many ways a key position in the new society, to remain apart from the community and to be kept apart because the medical teachers fail to appreciate their vocation. New teachers must be carefully chosen, because they must be fit to educate the new generation of physicians in the principles of the physicians' new communal task in every sphere of medical science."

L'Oeuvre of April 19 states that "the discontent of the medical profession can not be denied. Many of the members of the Council of the Order, themselves—with the exception of a few young men somewhat prematurely appointed, won over from the start to the methods of the iron fist and favoring authoritarian decisions—view with some disquiet the upsetting of professional traditions which were a guaranty for the patients as well as for the physician and which it is not enough to call 'routine' to render ineffective. There is no art in which it is more necessary to have long experience before passing judgment. The decrees which Vichy produces each day by the dozen, replacing the unwritten laws, are particularly severe for the medical profession. New tasks are perpetually being imposed, while its independence and possessions are ceaselessly diminishing. If there is any need to reduce the gasoline ration, the authorities take care not to tamper with the rations of the black market or of private cars which still take women and children for rides in Paris, but the cars of the country doctors are the first to suffer. And the last possessors are made to become co-proprietors of their car, regardless of whether the doctor they share with has the same rounds or not. As for the patients, who cares? One would like to know the bureaucrat who conceived this bright idea. The obligatory contributions for family allowances are three times as much for the medical profession as for any other. Why? Because the state subsidizes all other funds except those of the physicians. Why this exception? And the physician is now inflicted with far more graceless tasks than ever before. Medical certificates are perpetually in demand for the diets of his patients, for the wood and coal rations of old people and for the layettes of newborn babies. When the physician comes home, tired out with long walks and climbing innumerable staircases, he is faced with reams of clerical work, with all the certificates which await him. He also is responsible for all prophylactic measures against infectious disease and for the keeping up to date of statistics at the health services of the prefecture. He is now asked to point out to these same services those of his patients suffering from venereal diseases. The whole medical profession has risen in arms over this point, such a request to denounce one's patients being in fundamental opposition with the principle of professional secrecy. However lofty the motives of the venereal specialists in their fight against this disease, even though this denunciation is made into a contribution to statistical work, even though it is restricted to such patients as refuse to have intravenous injections over an indefinite period, it is distasteful to all physicians to practice with their patients such methods as are used only in the barracks and the brothel. Besides, the patients are wary nowadays. They pay their fee in cash and do not give their names. And the doctor has no more right to ask for their names than the priest in the confessional. . . . Is the medical profession still a liberal profession or is it to become a form of civil service?"

DBN of April 27 reports from Rowne that the German Sick Fund Institution for the Ukraine has been created for the reich Germans, who are carrying on their important work of reconstruction in the Ukraine, hundreds of kilometers from the homeland. Its task is to look after the maintenance of the health and the recuperation of all the reich Germans active in the Ukraine. Every reich German active in the reich commissariat of the Ukraine must contribute to this institution, if his income is under a certain amount, just as in the reich. In contrast with the reich, the Germans in the Ukraine are insured if their incomes are less than 600 marks a month, whereas in the reich the limit is 300 marks a month; this is because of the special importance of health conditions in the Ukraine area. Voluntary participation in the scheme is also possible. As double insurances are not permissible, those active in the Ukraine must have withdrawn from the sick funds to which they belonged in the old reich; but this withdrawal is only temporary. The membership of a sick fund in the reich lapses for the period of activity in the Ukraine.

The new institution will not be inferior in its benefits to any similar institution in the reich. The

contributions will be about as high as those in the reich. For those reich Germans who still draw their pay in the homeland, the contributions will be paid into the general sick fund of Katowice (Upper Silesia). Reich Germans in the Ukraine and their families in the reich will each receive a certificate enabling them to go to any doctor according to the system of free choice of doctors. By the creation of this sick fund institution a great work has been started, and the social welfare of the reich Germans in the Ukraine in the field of health insurance has been assured.

The Swedish trade union paper *Fackföreningsrörelsen* of April 24, in an article on the German labor situation, states that various regulations have been published against taking sick leave, especially in the armament factories. Press campaigns and meetings explain that to take holidays because of sickness is paramount to treason. In this connection it may be mentioned that the health condition of the German people has already been largely undermined by many years' hard work. The *Reichsgesundheitsblatt* contains sensational figures about the registered cases of illness in the reich over a period of forty-eight weeks in 1939 and in 1941:

	1939	1941
Diphtheria	128,897	154,752
Scarlet fever	119,730	226,755
Tuberculosis	69,502	88,312
Paratyphus	2,648	3,800

During the first twenty-five weeks of 1939 there were 6,135 cases of dysentery against 12,705 during the same period of 1941. Similar figures are shown for whooping cough. Compared with the difficult years preceding national socialist rule, these illnesses increased by from 500 to 800 per cent. The difficult conditions in Russia must have caused even these figures to rise greatly last year.

To increase the capacity of overworked soldiers and workers, more extensive use is being made of stimulants such as amphetamine. A luftwaffe doctor recently considered it necessary to issue a warning against such preparations in the *Deutsche medizinische Wochenschrift.*—*Journal of the American Medical Association.*

SCIENTIFIC BOOKS

POLIOMYELITIS

Neural Mechanisms in Poliomyelitis. By HOWARD A. HOWE and DAVID BODIAN. 234 pp. New York: The Commonwealth Fund. 1942. $3.50.

THE book entitled "Neural Mechanisms in Poliomyelitis" is a collection of previously published work on poliomyelitis carried out by Drs. Howe and Bodian. About 80 per cent. of the contents of the book appeared during 1941 in the *Bulletin* of the Johns Hopkins Hospital and with the exception of some cementing remarks the remainder is derived from the British publication *Brain,* from the *Journal of Experimental Medicine,* the *Proceedings* of the Society for Experimental Biology and Medicine, and the *Journal of Infectious Diseases.* While this book presents nothing new to those active in the investigation of poliomyelitis who have come to await eagerly and to digest each new publication of Drs. Howe and Bodian, it is, nevertheless, a most welcome volume because it brings together in systematic rather than chronological order the results of a series of investigations to which repeated reference will be found necessary and profitable by seasoned as well as beginning students of poliomyelitis and other neurotropic virus diseases.

A review of this book, therefore, is equivalent to an examination of the contributions which these investigators have made to our knowledge and understanding of the neural mechanisms in poliomyelitis. The work was begun about five years ago at a time when a great deal of data had already been accumulated on the behavior of many viruses (including that of poliomyelitis) with a special affinity for the nervous system. Because in addition to their obligate intracellular parasitism these viruses possess the unique property of spreading along specific nerve tracts in the peripheral and central nervous systems, it became increasingly clear that the mechanism by which they infect susceptible hosts could not be investigated properly without a thorough knowledge of the terrain over which they moved. Investigators whose primary training was in viruses had to become students of neuroanatomy before they could proceed. It was particularly appropriate and fortunate, therefore, that Drs. Howe and Bodian, whose basic training and contributions had been in the field of experimental neurology and neuroanatomy, should have entered upon the study of the neural mechanisms in poliomyelitis. In order to build upon a solid foundation much of their work consisted of a repetition and elaboration of the work of other investigators. Thus, they were able to confirm and adduce additional evidence for the following concepts: (1) that the virus of poliomyelitis moves along the axon rather than along the other structures of peripheral nerves; (2) that in the central nervous system (CNS) the virus acts only upon the neurons and not on any of the other structures, the mesodermal-glial component of the characteristic pathologic lesion occurring only in response to the neuron-virus reaction; (3) that the dissemination of the virus in the nervous

system is influenced by the specific tract connections of the affected neurons rather than upon the mere contamination of neighboring cells with virus; (4) that certain regions of the CNS are more resistant than others to the virus of poliomyelitis; (5) that in animals sacrificed in the preparalytic stage the regions affected vary with the central connections of the primary neurons involved in different portals of entry; (6) that even late in the paralytic stage of the disease produced by the M.V. virus in rhesus monkeys the olfactory bulbs are not affected except when invasion of the CNS has occurred along the olfactory pathway; (7) that when a thoroughly adapted monkey strain of poliomyelitis virus is instilled into the nose (thus reaching also the alimentary tract) of rhesus monkeys, paralytic poliomyelitis results only when the olfactory connections are intact, and (8) that the distribution of lesions in the central nervous system of human beings is essentially the same as that found in experimental animals infected by other than olfactory pathways.

Among the many new observations made by Drs. Howe and Bodian, the following are important as much for what they have revealed as for the new leads to future investigations that they have created. Their data suggest that, as in the case of some other neurotropic viruses, there is a latent period between the time axons are exposed and the time poliomyelitis virus begins to move in them towards the cell body, and that the original amount of virus entering the axon seems to reach the cell body without multiplication in the axon. Taking into account the probable latent period they estimated the rate of progression of one strain of poliomyelitis virus in the sciatic nerve of the rhesus monkey as 2.4 mm per hour on the assumption that the rate of progression is uniform. While one can not accept this as an established fact because the endpoint depends upon the result in a single monkey and the assumption of a uniform rate of progression has not yet been checked by experiment, there is, nevertheless, presented a method by which the rate of progression of various strains of poliomyelitis virus can be determined. They demonstrated the limited protective barrier of the pia by showing that while virus suspended in physiological salt solution and dropped on the uninjured pia failed to produce the disease, virus suspended in distilled water and administered in the same manner resulted in paralytic poliomyelitis. They presented the first really conclusive evidence that the alimentary tract can be a portal of entry for poliomyelitis virus by showing that it is possible to produce the paralytic disease in chimpanzees with surgically severed olfactory tracts when *virus of human origin* is given by mouth or by stomach tube.

Perhaps the most significant observation that has emerged from the labors of these investigators concerns the change in the behavior of certain susceptible neurons when their condition or metabolism is altered by severing their axons, particularly when this is done close to the cell body. The fate of a mitral cell in the olfactory bulbs, or an anterior horn cell in the lumbar cord, invaded by the M.V. strain of virus, is, under ordinary circumstances, complete necrosis. However, although no change in their reaction to this virus seems to occur for about a week after the axons of these cells are interrupted, they appear to become increasingly refractory thereafter, the maximum refractory state being reached at about three weeks and persisting apparently until effective regeneration has occurred. The effects observed were somewhat as follows. When the axons of certain groups of anterior horn cells were interrupted by cutting or freezing one sciatic nerve or by root section, and the monkeys, after a suitable interval, were given poliomyelitis virus by the intracerebral or intranasal routes, it was found that the nerve cells with the interrupted axons were spared, while extensive destruction of neighboring nerve cells had occurred. Similarly, when the olfactory tracts were cut, especially when this was done close to the bulbs, and virus was given intranasally after a suitable interval, the typical destruction of the mitral cells and the other associated lesions failed to take place. Drs. Howe and Bodian are inclined to interpret these data as indicating that the cells have become refractory to the effects of the virus, *i.e.*, that the virus reached the cells but was unable to destroy them. It would seem, however, that the existing evidence could also be interpreted to mean that the virus fails to invade the nerve cell because of its altered condition. I am more favorably inclined to the opinion expressed in the following sentence which appeared in their original communication but not in the book: "At the present time it is unknown whether the nerve cells are invaded by virus but not destroyed, or whether they no longer offer a foot-hold for it." In some experiments with another neurotropic virus I found that the centripetal movement of virus in the axon is dependent upon certain influences from the cell body. One would be justified, therefore, in considering the possibility that the spread of virus towards a nerve cell across a synapse may similarly be under the influence of the cell body toward which the virus is moving.

Drs. Howe and Bodian began their work at a time when critical investigators, guided by the available data, believed that the course of events in the human disease was essentially similar to that occurring in rhesus monkeys infected with the M.V. strain of virus. Recent studies, however, on the natural history of the

human disease and on the behavior of strains of virus of human or recent human origin in cynomolgus monkeys and chimpanzees have revealed rather different patterns of virus behavior, which appear to depend as much (or more) on certain qualitative differences between viruses derived from human beings and those thoroughly adapted to rhesus monkeys, as on the varying characteristics of the terrain in the different hosts. One may wonder, therefore, to what extent the neural mechanisms worked out with M.V. virus in rhesus monkeys may apply to the disease in human beings or experimental infection with other strains of virus. From what has been observed already, however, it would appear that regardless of what these other strains of virus may do in other tissues before invasion of the nervous system, the available evidence is still in favor of the view that that invasion occurs along specific peripheral nervous pathways and that the subsequent dissemination within the CNS is governed by the neuronotropism of the virus of poliomyelitis. The investigations of Drs. Howe and Bodian supply an excellent foundation for the future attack on the many unsolved and intriguing problems presented by the neural mechanisms in poliomyelitis and other neurotropic virus diseases, and as Dr. Thomas M. Rivers has indicated in a foreword to this book, it is highly desirable that virus workers in this field train themselves in "neurobiology" and that "neurobiologists" come to regard neurotropic viruses as a suitable *terra incognita* to invade.

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SPECIAL ARTICLES

ON PENICILLIN[1]

PENICILLIN, an antibacterial agent produced by the mold *Penicillium notatum*, was discovered by Fleming[2] in 1929. A chemical study of penicillin and the pigments produced by this mold was undertaken by Clutterbuck *et al.*[3] Last year the remarkable chemotherapeutic effect of purified penicillin, coupled with a low toxicity was reported by Chain *et al.*[4] A few months ago a more complete report by Florey and his collaborators[5] was published, including a method of purification.

Work on penicillin by our group was started over a year ago. In view of the practical importance of the subject it was thought advisable to publish some of our data at this incomplete stage.

For the routine test in this work a serial dilution method was used, employing 15- to 18-hour cultures of strain C203Mv, a group A hemolytic streptococcus. In some experiments this test was supplemented by the Oxford method,[5] in which the width of a zone of growth inhibition formed by the action of the agent on a heavily seeded agar plate culture is measured.

The culture fluid for the mold was a modified Czapek-Dox medium. In part of this work, the penicillin containing medium was supplied by the Charles Pfizer Company.[6]

Compared to other naturally occurring bactericidal substances like pyocyanine, gliotoxin, gramicidin or actinomycin, the isolation of penicillin proved rather difficult. This is due to the great instability of the agent and to the simultaneous production by the mold of many yellow pigments of similar chemical properties, which however are practically inactive as bactericidal agents.

In our procedure the culture medium is adjusted to pH 3–4, saturated with ammonium sulfate and extracted with chloroform. The active agent is removed from the concentrated chloroform extract by phosphate buffer at pH 7.2. Extraction with chloroform and buffer is repeated and the less acidic pigments separated from the most active fraction by chloroform extraction at different acidities. Penicillin is obtained from the concentrated extracts either as the free acid by precipitation from petroleum ether, or as the ammonium salt by saturation of a chloroform-benzol solution with dry ammonia gas. If the precipitation of the free acid is slow, it separates in yellow thick whetstone shaped crystals. The ammonium salt forms a dark yellow microcrystalline powder. In solution, penicillin, especially the free acid, is rather rapidly inactivated. The ammonium salt is more stable. In

[1] From the Departments of Ophthalmology and Medicine, College of Physicians and Surgeons, Columbia University, the Institute of Ophthalmology, the Edward Daniels Faulkner Arthritis Clinic, Presbyterian Hospital, New York, and the Research Division, Schering Corporation, Bloomfield, N. J. The authors submitted this paper on January 30, 1942, to the Committee on Medical Research of the Office of Scientific Research and Development who requested that publication be deferred pending official decisions on policy.

[2] A. Fleming, *Brit. Jour. Exp. Path.*, 10: 226, 1929.

[3] P. W. Clutterbuck, R. Lovell and H. Raistrick, *Biochem. Jour.*, 26: 1907, 1932.

[4] E. Chain, H. W. Florey, A. D. Gardner, N. G. Heatley, M. A. Jennings, J. Orr-Ewing and A. G. Sanders, *Lancet*, 2: 226, 1940.

[5] H. W. Florey, E. P. Abraham, E. Chain, C. M. Fletcher, A. D. Gardner, N. G. Heatley and M. A. Jennings, *Lancet*, 2: 177, 1941.

[6] We thank the Charles Pfizer Company for this material.

dry form both acid and salt keep only *in vacuo*. This procedure has given uniform results and a yield of over 50 per cent. of the original potency.

A considerable increase in stability of the solutions was obtained by acetylation or benzoylation of the ammonium salt. The free acids of the acyl derivatives form fine needles which have about the same *in vitro* activity as the mother substances.

The analysis of penicillin best fits the formula $C_{14}H_{19}NO_6$ or $C_{14}H_{17}NO_5+H_2O$. The Oxford authors have stated that their preparations are nitrogen free. All our highly active and pure preparations, including the acyl derivatives, analyze for one N atom. Chromatographic adsorption or treatment with charcoal did not lower the N content. Penicillin is strongly dextrorotatory and has an absorption maximum at 2750 A°.[7]

Biologically our preparations are inactive against *E. coli*. The minimal concentration showing activity against 2 to 3 million hemolytic streptococci per cc is at a dilution of 1:32 million. This corresponds to about 240 Oxford units per mg. The Oxford standard has an activity of 42 units per mg.

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THE REVERSAL OF PNEUMOCOCCUS QUELLUNG BY DIGESTION OF THE ANTIBODY WITH PAPAIN

IN a recent study[1] we have been able to remove the antibody by means of digestion with the proteolytic enzyme papain and recover several neutralized biologic agents in the active state. Among the agents studied was Pneumococcus, Type I, and it was found that it regained its virulence for the mouse (even after gross overneutralization) when the suspension of neutralized pneumococci was treated with papain.

Since there is no clear evidence as to the nature of the Quellung phenomenon, we thought it worth while to investigate whether the reactivation of the pneumococci was accompanied by reversal of the Quellung as a result of the action of papain, since such a result would indicate that the Quellung merely represents the addition of antibody with no further mechanism needing to be postulated. In fact, Etinger-Tulzynska,[2] on the basis of experiments wherein the Quellung reaction was reversed by means of heat treatment, postulated that the Quellung phenomenon was merely a visualization of the capsule that was already there. Nungester and Kempf[3] have likewise claimed that there is a reversal of the Quellung upon the addition of specific soluble substance, which in fact may represent the removal of antibody, although this involves assuming that the antibody was "pulled" off the pneumococcus by the soluble polysaccharide.

Our investigations were carried out in the following manner: Equal volumes of twenty-four hour tryptose broth culture of Pneumococcus Type I and undiluted antibody (rabbit serum) were mixed and a small portion was immediately removed and examined under the microscope for Quellung, which was plainly evident in a few minutes. The remainder of the mixture was incubated at 37° C. for thirty minutes, after which time a small portion of activated papain was added to half of the quelled pneumococcus suspension, and as a control papain, which had not been activated, was added to the other half. It was noted that, in the presence of the active papain, in a few minutes the clumps of agglutinated pneumococci were dispersed and went into a homogeneous suspension. Examination of the digested mixtures after about thirty minutes' incubation indicated a complete loss of the Quellung, while the control mixture with inactive papain remained agglutinated and swollen.

In order to ascertain whether the de-quelled pneumococci were capable of being re-quelled, after the digestion had taken place, the bacteria were spun down in the angle centrifuge and washed five times with saline in order to remove the enzyme. More serum was then added and Quellung occurred almost immediately. Thus, the cycle has been completed; it has been possible to reverse the Quellung by means of the removal of antibody and to re-quell the same pneumococci by the addition of more antiserum.

This experiment indicates that the Quellung merely represents the addition of antibody, an explanation which has been suggested.[4] We can bolster this theory by pointing out that from the quantitative point of view it is possible for the antibody to account for the increase in size, simply by its own volume. This is possible since we now have knowledge of the amount of antibody which the very same culture pneumococcus takes up.[5]

White[6] gives the size of the pneumococcus as from 0.5–1.2 μ. Taking as an average a diameter of 0.8 μ, or a radius of 0.4×10^{-4} cm, the volume of a sphere

[7] We thank Dr. H. Darby for the spectrographic analysis.

[1] G. Kalmanson and J. Bronfenbrenner, *Federation Proceedings*, 1: 2, 179, 1942.

[2] R. Etinger-Tulzynska, *Ztschr. f. Hyg. u. Infectsionkr.*, 114: 769–789, 1933.

[3] W. J. Nungester and A. H. Kempf, *Proc. Soc. Exp. Biol. and Med.*, 43: 705–706, 1940.

[4] A. D. Hershey, *Jour. Immunol.*, 42: 485–513, 1941.

[5] A. D. Hershey, *Jour. Immunol.*, 39: 383–396, 1940.

[6] B. White, "The Biology of the Pneumococcus," p. 31. Oxford University Press. 1938.

may be calculated by simple geometry ($V = 4/3\,\pi R^3$) to be 2.7×10^{-13}ml. Since one pneumococcus takes up 4×10^6 antibody molecules, which represents a volume of 8×10^{-13} ml,[5] the addition of antibody would result in a new volume of 10.7×10^{-13} ml. Calculating the radius corresponding to this volume gives a new radius of 0.63×10^{-4} cm, or about 1–1/2 times the original one. These figures are necessarily quite rough, but the order of magnitude is probably approximately correct.

While we have not conducted any experiment to determine the increase in volume of the sensitized pneumococcus, we have found in the literature photographs, which indicate that in Type I Pneumococcus the swelling is probably not more than about twofold.[2,7] Thus the figure arrived at by simple calculation of antibody volume seems reasonable, and becomes even more cogent, when it is realized that this calculation assumes complete packing of the antibody, leaving no free space between antibody molecules, and since this is certainly unreasonable for physical reasons, the addition of antibody in fact could account for even greater degree of swelling than that calculated above.

The experiments have been of interest in another connection. Since the papain can reactivate neutralized biologic agents, it was thought that it would be a useful tool in isolating viruses in tissues where failure to infect could be due to the presence of neutralizing antibody. We attempted to carry out this in the case of rabbit papilloma, where failure to recover the virus from the papillomae of domestic rabbit was suggested to be possibly due to the presence of antibody but, unfortunately, preliminary experiments showed that this virus[8] is destroyed in a short time by the action of the enzyme so that the experiment could not be carried out satisfactorily.

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DESTRUCTION OF RIBOFLAVIN BY LIGHT

IN the course of conducting riboflavin assays in foodstuffs in association with Professor H. C. Sherman, a few observations were made of the extent of loss of this nutrient in the cooking of certain foods. It seemed noteworthy that large losses, up to 48 per cent., occurred in instances in which the cooking was done in open vessels so that the food was exposed to light during cooking. In view of the present recognition of wide-spread ariboflavinosis in human beings in the United States, an occurrence which is not clearly traceable to specific recent alterations of food habits, it seemed that light destruction at the high temperatures reached in cooking might be of practical importance.

Although György and coworkers[1] and Roscoe[2] noted the phenomenon of photochemical destruction of riboflavin, we are not aware of any study of the temperature coefficient of this photochemical reaction. The effects of temperature and hydrogen ion concentration on the rate of photochemical destruction of riboflavin in water solution are recorded in Table I.

TABLE I

LIGHT DESTRUCTION OF RIBOFLAVIN IN SOLUTION

Time of exposure, minutes (Temperature—100°C.)	Per cent. destruction		
	pH 3	pH 4.5	pH 6.5
5	16	28	42
15	42	62	72
30	60	84	91
45		90	99
60	95	97	> 99
Time of exposure, 1 hour	**Per cent. destruction**		
	Temperature		
	32°	75°	100°
pH 3			95
pH 4.5	16	66	97
pH 6.5	51	> 99	> 99
DARK, 100° for 1 hour	**Per cent. destruction**		
pH 4.5		1	
pH 6.5		0	

These experiments were carried out during early afternoon on sunny days in a well-lighted room, simulating usual kitchen conditions. The illumination was not constant but approximated 60 foot candles on the side of the tubes facing an east window five feet away. The initial concentration of all solutions was 0.1γ/cc. Residual concentrations were determined by the microbiological method of Snell and Strong.[3]

It is apparent from Table I that increases either in alkalinity or temperature accelerate the destruction of riboflavin, at a quite rapid rate. Temperature and pH affect the light reaction rather than other chemical destruction, for when riboflavin solutions are heated in the dark no destruction occurs.

In view of these results it was of interest to test

TABLE II

DESTRUCTION OF RIBOFLAVIN IN MILK AND EGGS

Time of exposure, minutes 100°C.	Per cent. destruction	
	Milk	Eggs
5	26	
15	39	22 (open metal pan)
15		8 (closed pan)
30	48	
45	64	
45 (dark)	5	2 (steamed in autoclave)

[1] P. György, R. Kuhn and T. Wagner-Jauregg, *Naturwissenschaft*, 21: 560, 1933.

[2] M. H. Roscoe, *Biochem. Jour.*, 27: 1540, 1933.

[3] E. E. Snell and F. M. Strong, *Ind. Eng. Chem., Anal. Ed.*, 11: 346, 1939.

[7] A. F. Sabin, *Jour. Am. Med. Asn.*, 100: 1584–1586, 1933.

[8] Kindly sent to us by Dr. J. W. Beard.

more accurately the temperature coefficient of photochemical destruction of riboflavin in foods which represent good riboflavin sources.

Samples of fresh skim milk and beaten raw eggs were heated under the conditions described above. The results are listed in Table II.

From Table II it is evident that light destruction of riboflavin in liquid foods proceeds at a rapid rate, although it is somewhat slower than the destruction in clear solutions. The opacity of many foods tends to prevent excessive riboflavin losses during cooking, but large losses in foods such as milk and eggs, which alone contribute approximately 40 per cent. to 50 per cent. of the riboflavin supply in the average American diet, may appreciably aggravate shortages of the vitamin.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

RECLAIMING AGAR FOR BACTERIOLOGICAL USE

WITH the cessation of imports, an acute shortage of agar may be encountered before new sources can be developed. Two proposed substitutes under study in our laboratory, carrageen and sodium alginate, which are also extractives from marine plants, do not appear very satisfactory.

The procedure for reclaiming agar from media herein presented is a modification of the method used by us for several years to purify commercial crude agar. The treatment produces a product which is actually superior to the common commercial agars being used by bacteriologists. Such reclaimed agar has a hardness of approximately 100 compared to 20–50 as determined by our hardness apparatus,[1] has an ash content of 1 per cent. or less compared with an average of 4 per cent. (our findings and those of Whitaker[2]) and a crude protein nitrogen content of 1 to 2 mg per g, which is ½ to ¼ less than commercial samples. Also most of the non-solidifying gum content (30 to 40 per cent.) is removed. The nitrogen content can be still further reduced by treatment with pancreatin, but this has not been considered necessary.

The used culture medium is sterilized, made slightly alkaline to litmus and filtered through cheesecloth and absorbent cotton. It is then cooled slowly until solidified. The layer of sediment is removed and the agar is shredded by passing it through a fine wire screen of at least 16 mesh. After a preliminary washing of several hours in a cheesecloth bag by running water to whiten, the bag is transferred to a container for infusion with tap water with stirring at intervals. The water should contain a residual or added calcium salt. Sodium hypochlorite is added (excess detected by odor) primarily to prevent bacterial growth. The temperature of infusion should not exceed 50° C. The waste filtrate is siphoned off and fresh water added at intervals. After 6 to 8 infusions covering several days the excess water is drained from the agar and traces of hypochlorite and salts are washed out with distilled water. Depending on laboratory facilities, the agar may be either evaporated down on a steam bath or frozen and thawed to remove more water or dried directly in thin layers in an oven at 50° C. to 70° C. and finally at 100° C. When dry, the pieces of agar may be weighed and soaked preliminary to use or may be ground to a powder by aid of a hand mill.

Agar can also be reclaimed from blood-agar and differential media containing indicators and dyes as phenol red, E.M.B. and Endo. Such dye-containing media as Endo's should be processed separately however, and the infusions should be of acid reaction to intensify bleaching. The types of infusion containers preferred are glass or porcelain enamel and the quantity of waste agar should be several liters or more.

At times when a sufficient quantity of waste agar is not available for processing, it may be oven- or sun-dried by pouring in thin layers in pans and stored dry in bottles. This practice of drying and storing of waste agar may be found advisable even in laboratories which appear to have ample reserves of stock agar. For in case no more can be purchased, the waste agar can be reclaimed.

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[1] *Jour. of Bacteriology*, 41: 1, 32, 1941.
[2] *Jour. Am. Pub. Health Asn.*, 1: 632, 1911.

RECLAMATION OF USED AGAR

SINCE virtually all commercial agar was obtained from Japan, laboratories and other institutions using this product in the preparation of solid culture media are faced with the same serious situation as the various industries preparing rubber products. Until a satisfactory substitute for agar can be obtained, it is obvious that present supplies must be used sparingly and the possibility of reuse should be carefully investigated.

A few reports of reclamation of used agar have appeared in the literature which vary in procedure

from the simple reheating and resolidifying of the medium to methods so complex and expensive as to be impractical.

At this station, where 6,000 to 7,500 grams of agar are used weekly in the preparation of *Brucella* antigen and vaccine and routine bacterial culturing, a procedure for the reclamation of used agar has been developed which has proved extremely satisfactory.

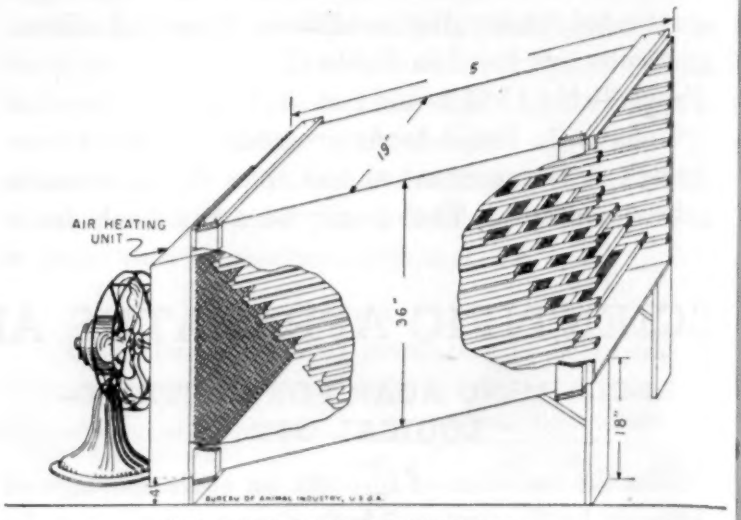
After the removal of the bacterial growth, the medium in flasks and tubes is heated in an autoclave at 15 pounds' pressure for 30 minutes. The melted medium, while still hot, is poured into glass vessels or crocks, preferably larger in diameter at the top than at the bottom. It is allowed to cool slowly in order that solid substances present will gravitate. When the medium has gelled, it is removed from the container and the bottom portion containing the sediment is excised and retreated in like manner until only sediment remains, which is discarded. The recovered medium is forced through a $\frac{1}{8}''$ mesh screen and the particulated material is placed in a 50- to 60-mesh cotton bag. At this station, where large quantities are handled, 100-pound bags are used. The bag is placed on a raised screen base in a tub or large box which has an outlet on the bottom. A rubber hose is inserted in the center of the bag, the open end of the bag tied around the hose, and the other end of hose is attached to a cold water spigot.

A slow stream of water is allowed to flow on the medium. The occasional kneading of the bag will remove air and allow the water to trickle throughout the medium. At first, the wash water is a clear dark brown and gradually becomes lighter. Washing is continued for at least 10 hours, usually overnight, when the agar has become a grayish white. Both wash water and agar at this point are negative to the Biuret test. When the washing is completed, the bag is left on a stand until most of the free water content has drained.

The agar is then gently spread on specially prepared screen trays and placed in a drying cabinet for evaporation.

The cabinet is about $60'' \times 19'' \times 36''$, open at both ends, and made of plyboard. It holds 10 evaporating trays, spaced about 2″ apart and so arranged that air forced through the box is baffled to insure even evaporation. The trays, $18'' \times 36''$, are made of $1'' \times 2''$ wood frame material, strengthened by a median brace. A heavy galvanized iron, $\frac{1}{4}''$ mesh hardware cloth is attached to the frame, over which is placed a 16-mesh wire screening.

Air is forced into the box by a 16″ circulating fan which passes the air primarily through a steam, room-heating element which heats the air to approximately 80° C. After about 12 hours in the evaporating box, the dried agar is only slightly darker than the original material. It is crisp and has the appearance of a flattened sponge sheet, and easily removed from the wire screen in sheets.



DRYING CABINET USED IN RECLAIMING AGAR

FIG. 1.

Media prepared from this reclaimed agar are very slightly, if any, darker than media prepared from U.S.P. agar. It has been tested in other laboratories with more than 30 different microorganisms and the results have been uniformly satisfactory.

In several tests made, it has been estimated that 75 to 80 per cent. of agar treated in the manner described is recovered, which includes the initial loss adherent to flasks in pouring.

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